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(54) DEVICE FOR REGULATING THE WINDING TENSION OF GUIDED MATERIAL IN THE FORM OF A WEB

(71) We, TEXMA MASCHINENGESELLSCHAFT MIT BESCHRANKTER HAFTUNG, trading as GEBRUDER SUCKER, a German Body Corporate, of 461 Eickener Strasse, Monchengladbach, Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to a device of regulating the winding tension of guided material in the form of a web.

Devices of this kind are used in the textile industry, e.g. on beaming machines in sizing installations, but can also be used for winding, re-winding and unwinding in other branches of the textile or paper processing industry.

For regulating the winding tension of guided material in the form of a web, a process is known wherein the web passes over a movable tension measuring roller directly to a take-up roller, movement of the tension measuring roller in dependence upon the web tension serving to vary the winding speed.

It is possible to provide an additional deflecting roller between the tension measuring roller and the take-up roller, so that the angle of loop of the web on the measuring roller is always kept constant. The term "angle of loop" is defined below. Additional looping rollers of this kind, however, suffer from the drawback that the space required inside the machine increases considerably and the machine has to be made larger. This detracts from accessibility and greatly limits the size of the rolls that can be produced.

In order to avoid this drawback it is sometimes found indispensable to arrange the tension measuring roller in such a way that the angle of loop does not remain constant as the diameter of the roll changes. The disadvantage of this and similar devices resides in the fact that the angle of loop may vary considerably between the minimum and maximum roll diameter.

These differences become greater still if, owing to a change of batch, for example, the direction of rotation of the take-up roller has to be changed at very short notice and the way in which the tension measuring roller is arranged inside the machine cannot be changed as required. The changes in the angles of loop on the tension measuring roller then lead to different tensions in the material.

In a further device of this kind which has become known the tension measuring roller situated directly upstream of the take-up roller has been caused to move outwards as the roll diameter increases as the winding operation proceeds, in such a way that the angle of loop, once selected remains constant. This system, however, involves considerable outlay on regulating apparatus and does not always give completely satisfactory results.

According to the invention there is provided a device for winding a web, the device comprising web feeding means including a movable tension measuring roller over which the web passes directly to a take-up roller, whereby the angle of loop of the web (as hereinafter defined) and thus the force exerted on the tension measuring roller by the winding web under a given tension varies as a web roll builds up on the take-up roller and in which device the tension measuring roller is biased against the web in order to sense the tension thereof, tension adjusting means being actuated by movement of the tension measuring roller and means being provided for varying the biasing force of the tension measuring roller as the web roll builds up on the take-up roller to enable the tension measuring roller to correctly measure the web tension throughout the winding of the web roll. Advantageously, the feeding means further includes a fixed delivery roller over which the web passes directly to the ten-

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sion measuring roller, whereby the angle of loop of the web (as herein defined) varies as the web builds up on the take-up roller.

The present invention provides a device in which the biasing force is modifiable in accordance with the angle of loop on the tension measuring roller. For this purpose the change in the angle of loop can be determined, for instance, by means of known electro-optical scanning devices. As a change in the angle of loop is governed by the roll diameter, however, this latter can likewise be continuously scanned, its magnitude being taken as a measure of the angle of loop. Since in a device for maintaining the tension in the web constant during winding the winding speed at any moment bears a certain ratio to the roll diameter, a further possible criterion for the roll diameter and thus for the angle of loop is provided by the condition of a device determining the winding speed, e.g. the angular position of an adjusting shaft on a winding gearing.

The tension measuring roller is subjected to a certain prescribed biasing force preferably by means of elements articulated to the tension measuring roller and operated hydraulically of pneumatically, e.g. by pistons and cylinders. In this case, however, the operation of modifying the pressure in the hydraulic or pneumatic system in such a way that the biasing force acting on the tension measuring roller is adapted to the angle of loop is a complicated and expensive one. The reason for this is that the pressure within the hydraulic or pneumatic system is required to remain controllable, in accordance with the desired biasing force, throughout the entire pressure range, although changes in the position of the tension measuring roller would necessitate a superimposed pressure adjustment.

In order to avoid this drawback the biasing force can be regulated, according to a further feature of the invention, by making the said force modifiable by means of an adjustable lever system. In this case the biasing force can be produced by at least two hydraulically or pneumatically actuated pistons acting on one or more arms of a lever system. Thus, the means for varying the biasing force may comprise an adjustable lever system wherein, one embodiment of the lever system comprises a piston and cylinder device on one side thereof, with the tension measuring roller on the other side thereof, while in an alternative embodiment, the lever system comprises a first piston and cylinder device on one side thereof, with a second piston and cylinder device and the tension measuring roller on the other side thereof. The piston rod of a cylinder preferably is engaged in a slide block which is operatively connected with the tension measuring roller. As the roll diameter changes the consequential deflection of the tension measuring roller actuates a servo-motor which adjusts the winding gearing. This adjusting movement results at the same time, by a pivoting movement of the cylinder, in a displacement of the piston rod inside the slide block, altering the point of engagement of the former in the latter in such a way that the constant hydraulic or pneumatic pressure in the cylinder acts in an intensified or reduced degree on the tension measuring roller, via the lever system.

In a particularly advantageous embodiment the lever system can be adjusted by means of a drive controllable in response to impulses received from programme transmitters, such as programme discs, magnetic tapes or the like, which are equipped with impulse transmitters and are designed in accordance with the desired winding characteristic for the take-up roller to predict the variation in the angle of loop. For example, the deviations occurring within the prescribed winding tension as a result of loop may be so slight over a certain winding range, at the beginning of the winding process, for instance, that they are still within a certain accepted tolerance, so that no change in the biasing iofnse crnecesasry. If however the changes in the angle of loop on the tension measuring roller become more noticeable as the roll diameter increases, the regulating process can be introduced when a certain roll diameter is reached.

When the regulating process takes an uneven course of this kind the impulse transmitters can take the form of perforated discs or contact discs. A wide variety of distances or graduations between the individual regulating steps can be accommodated on such discs in a particularly simple manner, so that they can be adapted to any desired winding characteristic. To enable the regulating programme with disc-shaped impulse transmitters to be extended beyond one single rotation of the discs, or to ensure that the smallest distances or graduations between the individual regulating steps can be accommodated on the periphery or in the interior of a disc, it is particularly advantageous for the programme transmitter to consist of a number of contact or entrainment discs which commence to rotate in succession.

According to a further preferred feature of the invention, however, the device used for the adjustment of the lever system can also consist of a cam gear with cams taking a course corresponding to the winding characteristic of the winding beam.

As already mentioned, rolls have to be produced in both winding directions on one and the same machine. It follows that the

angle of loop on the tension measuring roller decreases from the minimum to the maximum winding diameter in one case and increases in the said direction in the other case. To ensure that the device is applicable to winding in both directions, the said mounted in such away that in one pivotal roller can with particular advantage be position thereof, a plane passing through the axis of the take-up roller and tangent to the tension measuring roller intersects, on the surface of the tension measuring roller, a plane passing through the axis of the tension measuring roller and the pivotal axis of the latter when it occupies its prescribed position. With a system so designed the control can be effected with the same means for both winding directions.

Constructional embodiments will now be described purely by way of example with reference to the accompanying drawings in which:

Fig. 1 is a schematic diagram of a winding device.

Fig. 2 is a sectional diagram of a detail from Fig. 1.

Fig. 3 shows a further example of the winding device illustrated in Fig. 1.

Fig. 4 shows an example of a detail from Fig. 3.

Fig. 1 shows the material 2 which is arriving in the form of a web from the direction shown by the arrow 1 and which is supplied from a delivery roller device consisting of the rollers 4, 5 and 6, at a constant delivery speed, to take-up roller 3, on which it is wound. In this process the delivery roller 5 rotates about a fixed shaft 5^1 while the shafts 4^1 and 6^1 are mounted pivotably instead of rigidly. The shaft 6^1 of the tension measuring roller 6 is affixed by means of the arm 7 to a segment disc 8 which is mounted at the point 8^1 eccentrically in respect of the delivery roller 5. To the segment disc 8 is affixed a chain 9 which passes over a deflecting roller 10 to a sprocket wheel 11 and which is connected with this latter likewise. The sprocket wheel 11 is connected with a shaft 12 in a torsionally rigid manner. In the same way a slide block 13 is affixed by a cogwheel 14 on the shaft 12. The cogwheel 14 engages a rack 15 which rests on a roller 16 and which is connected with a piston 17. The piston 17 is guided in a hydraulic cylinder 18. A driving unit 20 produces an adjustable pressure which acts on the piston 17 and is indicated by a pressure gauge 19. The same pressure acts on a piston 23, which is guided in a cylinder 24 pivotable about a shaft 25. The piston 23 is mounted on one end of a piston rod, the other end of which carries a roller engaged in the slide block 13. The hydraulic pressure exerted on the piston 23 and the tension of the material 2 at the tension measuring roller 6 both tend to rotate the cogwheel 14 anti-clockwise, but these forces are balanced, at equilibrium, by the hydraulic pressure on the piston 17 which acts to rotate the cogwheel 14 clockwise.

If the tension of the material increases during the winding process, the tension measuring roller 6 with segment disc 8 moves in the clockwise direction about the point 8^1. This movement is transmitted via the chain 9, the sprocket wheel 11 and wheels 26 and 27, with a driving device 28, to a throttle valve 21. The throttle valve 21 adjusts an hydraulic motor 22, which in its turn, via an intermediate gearing 29 with a wheel 30, a driving means 31 and a wheel 32, adjusts a winding gearing 33 in such a way as to reduce the rotational speed of the take-up roller 3 driven by means of discs 34 and 35 and a driving means 36. The reduction in the rotational speed of the take-up roller 3 reduces the tension of the material, and the tension measuring roller 6 returns to its original position. The winding gearing 33 is driven by a motor 53.

As the roll builds up, however, the angle of loop of the material 2 passing round the tension measuring roller likewise changes. The angle of loop is defined as the angle subtended at the centre of the tension measuring roller 6 by that part of the circumference thereof which is in contact with the web material.

The arrows 37 and 38 show the two directions of rotation in which the material can be wound onto the take-up roller. If the winding takes place in the direction shown by the arrow 37, lines 39 and 40, which show the material with its minimum and with its maximum roll diameter, indicate the reduction undergone by the angle of loop. Lines 41 and 42 clearly show how, on the reversal of the winding direction (arrow 38), the angle of loop on the tension measuring roller 6 increases during the building up of a roll. In both cases the resultant force on the tension measuring roller becomes smaller. The change in the angle of loop on this tension measuring roller 6, would therefore cause the roller 6 to move and thus influence the winding speed and thereby, the tension of the material if it were not for the fact that, in accordance with the invention, the biasing force acting on the tension measuring roller, in accordance with the desired tension for the material, is modifiable as the angle of loop on the said roller changes. In the example shown in Fig. 1 this modification of the biasing force is effected as follows: The means for producing the biasing force consists of two hydraulic cylinders 18 and 24 of which the pistons 17 and 23 are both

subjected to the same pressure. In this process, in order to adapt the biasing force to the changing angle of loop, the lever arm component of the force exerted by the piston 23 is modified. This is why the cylinder 24 is rotatably mounted on the shaft 25. The pivoting of the cylinder 24 is effected via a servo-motor 43 by means of the gearing 44. A programme transmitter 49, which consists of a contact disc 50 taking the form of a perforated disc, is connected with the adjusting shaft 45 via a wheel 46, the driving element 47 and a further wheel 48. The number of borings 51 in the contact disc 50 and the distances between them are selected in accordance with the winding characteristic of the take-up roller 3 and scanned by a light barrier 52. The winding characteristic of the take-up roller is the predicted change in the angle of loop as the web builds up on the take-up roller. The servo-motor 43 adjusts, via the gearing 44, a driving element 54 and a wheel 55, and also a second contact disc 57 which is provided with a light barrier 58 and which serves as a programme receiver 56 and which, after further rotation by one perforation pitch 59, shuts off the servo-motor 43 by means of a switch 60.

Fig. 2 shows an advantageous arrangement of a number of contact or entrainment discs situated in succession and serving to control the biasing force. This diagram shows a shaft 61, with which a disc 62, continuously braked by a braking device 63, is rigidly connected. The driving element 47, via the wheel 48, first of all imparts one rotation to the entrainment disc 50, until the contact pin 66 encounters the contact pin 67 of the second entrainment disc 68, taking the latter with it through a further rotation. When the contact pin 69 has come to rest against the contact pin 70 of the contact disc 71, the programme accommodated on the contact disc 71 can take effect within a further rotation. In this manner the programme transmitter shown in this embodiment can effect a control operation. That is, during two rotations of the adjusting shaft 45 of the winding gearing 33 no regulating operation is carried out, whereas during the third rotation the disc 71 rotates. The entire periphery of the contact disc 71 is available for the greatest possible number of small control stops for the control of the desired winding characteristic. If necessary it is also possible for the entrainment discs 50 and 68 themselves to be fitted with additional contacts, so that the control programme is spread still further. By one or more simple entrainment discs preceding a contact disc 71 even the smallest part to be controlled from an over-all regulating route can be extended to a full rotation without interrupting the continuous rotatory movement starting from the winding gearing 33.

In its essential structure the example shown in Fig. 3 corresponds to that illustrated in Fig. 1. Here again the diagram shows the take-up roller 3 with the feed device consisting of the rollers 4, 5 and 6, the winding gearing 33, the programme transmitter 49 and the programme receiver 56. Here again the means used for adjusting the winding gearing consists of an intermediate gearing 29 on which the driving unit 20 acts in accordance with the position of the tension measuring roller 6. In contradistinction to the example shown in Fig. 1, however, the cylinder 24 in that shown in Fig. 3 now supplies the entire biasing force by itself. The direction in which the chain 9 passes over the sprocket wheel 12 must be reversed. Unlike the version shown in Fig. 1, this present example, which is simpler, owing to the absence of the cylinder 18 and the accessories, nevertheless necessitates a far larger pivotable cylinder 24. Furthermore, in the example shown in Fig. 1, in the event of a change of beam, the cylinder 18 can be switched off and the chain tension reduced to zero by means of the cylinder 24, without the need for any modification to the pressure control system of the said cylinder 24. In this process the tension measuring roller 6 can be pivoted downwards, whereupon, owing to the eccentric position of the point 8^1, a gap is formed between the roller 5 and the tension measuring roller 6. This gap is particularly advantageous for the purpose of increasing the thickness of the material in the web.

Fig. 4 shows a cam gear which can replace the contact discs already described as a means of controlling the biasing force. The diagram shows a pivot gearing 72 which is driven by the adjusting shaft 45 of the winding gearing 33 and which imparts a pivoting movement to a lever 73 during the building up of the roll. An extension arm 74 is pivotably mounted on the upper end of the lever 73 and guided with a roller 75 in the curved groove 76 the course of which is determined by the winding characteristic. A fork 77, rigidly connected to the wheel 78, acts on the said roller 75. By the displacement of the roller 75 in the curved guide 76 the fork 77 is pivoted with the wheel 78, this pivoting movement being transmitted via a driving element 79 to the rotation shaft 25 of the cylinder 24, thus likewise modifying the lever arm ratio of the force exerted by the piston 23.

WHAT WE CLAIM IS:—

1. A device for winding a web, the device comprising web feeding means including a movable tension measuring roller over

which the web passes directly to a take-up roller, whereby the angle of loop of the web (as hereinbefore defined) and thus the force exerted on the tension measuring roller by the winding web under a given tension varies as a web roll builds up on the take-up roller and in which device the tension measuring roller is biased against the web in order to sense the tension thereof, tension adjusting means being actuated by movement of the tension measuring roller and means being provided for varying the biasing force of the tension measuring roller as the web roll builds up on the take-up roller to enable the tension measuring roller to correctly measure the web tension throughout the winding of the web roll.

2. A device as claimed in claim 1, wherein the feeding means further includes a fixed delivery roller over which the web passes directly to the tension measuring roller, whereby the angle of loop of the web (as hereinafter defined) varies as the web builds up on the take-up roller.

3. A device as claimed in claim 1 or 2, wherein the means for varying said biasing force comprises an adjustable lever system.

4. A device as claimed in claim 3, wherein the lever system comprises a piston and cylinder device on one side thereof, with the tension measuring roller on the other side thereof.

5. A device as claimed in claim 3, wherein the lever system comprises a first piston and cylinder device on one side thereof. with a second piston and cylinder device and the tension measuring roller on the other side thereof.

6. A device as claimed in claim 4 or 5 further including hydraulic or pneumatic means for actuating the or each piston and cylinder device.

7. A device as claimed in any one of claims 2 to 6, wherein the means for varying said biasing force includes means for predicting the variation in the angle of loop as the web builds up on the take-up roller.

8. A device as claimed in claim 7, wherein the means for varying said biasing force further includes means for producing a control impulse signal dependant upon the prediction, and means for receiving the control signal and acting upon it to alter the balance of the lever system whereby the biasing force is altered.

9. A device as claimed in claim 7 or 8 wherein the means for predicting the variation in the angle of loop comprises a plurality of contact or entrainment discs which are situated side by side and which commence to rotate in succession.

10. A device as claimed in claim 7 or 8 wherein the means for predicting the variation in the angle of loop comprises a cam, a cam follower, and means for moving the cam follower over the cam as the web builds up on the take-up roller, the cam follower being linked to the tension measuring roller and the cam being so shaped in accordance with the predicted variation in the angle of loop that as the web builds up on the take-up roller, the biasing of the tension measuring roller is varied by the cam follower moving over the cam, to maintain the tension of the web constant.

11. A device as claimed in any preceding claim, wherein the tension measuring roller is pivotally mounted.

12. A device as claimed in claim 11 wherein, in one pivotal position of the tension measuring roller a plane passing through the axis of the take-up roller and tangential to the tension measuring roller insects, on the surface of the tension measuring roller, a plane passing through the axis of the tension measuring roller and the pivotal axis of the latter.

13. A device for winding a web onto a take-up roller substantially as hereinbefore described with reference to the accompanying drawings.

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Sheet 1

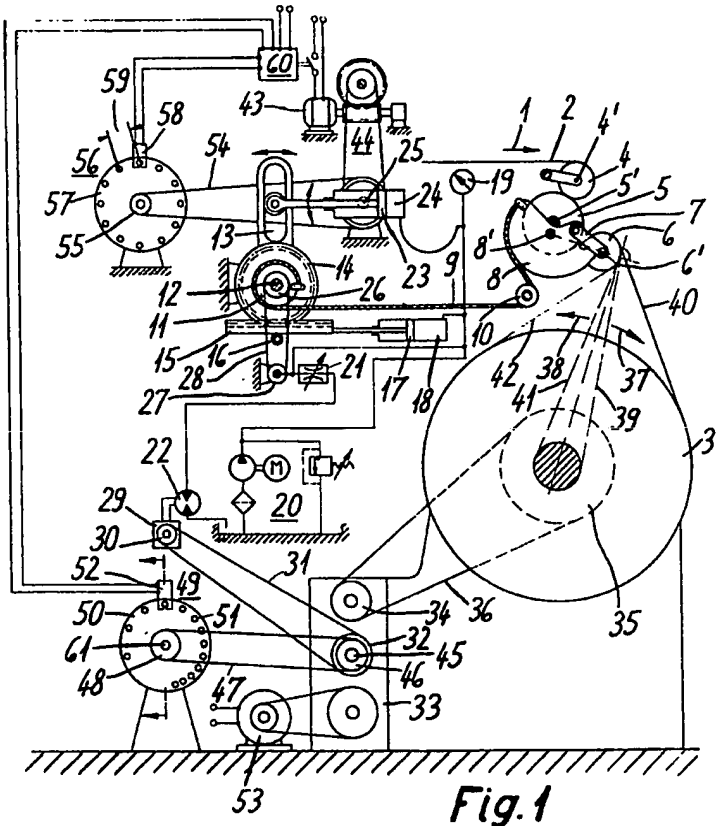

Fig. 1

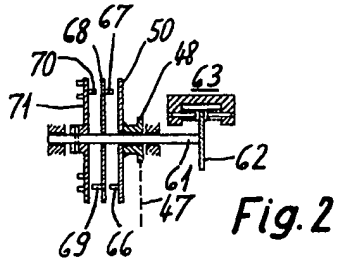

Fig. 2

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Sheet 2

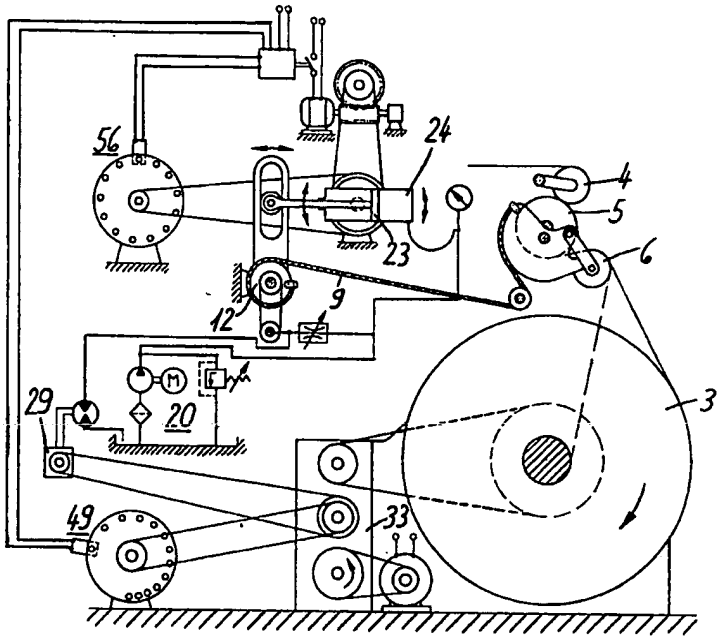

Fig.3

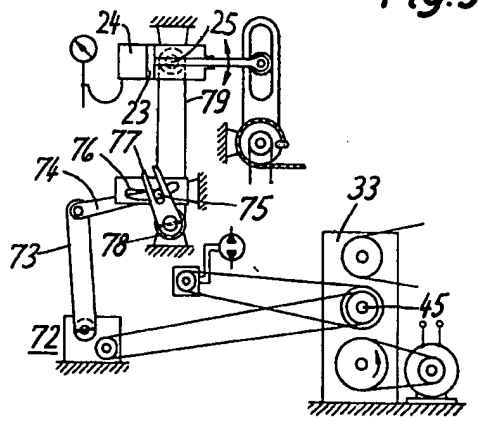

Fig.4